TETRA TECH

MEMO

To:	Robert Parker USEPA, Region VIII (8EPR-SR) 1595 Wynkoop Street Denver, CO 80202
From:	Aileen Molloy
Date:	Monday, April 24, 2017
Subject:	Silver Creek OU2/3 Tailing Volume Assessment

Tetra Tech was requested to estimate the tailings volume at parcels in OU2/3 based on the tailings thickness data provided by United Park City Mines (UPCM) in the document "Volume Tables and Main Volume Exhibit – working.pdf". UPCM also provided a Microsoft Excel spreadsheet file containing sites where soil sampling data was located along with geographic information (i.e., Latitude and Longitude) entitled "UPCM Notebook Datav2.xls". Parcel data (parcel boundaries and identification numbers) were obtained from the October 2016 update to the Summit County parcel data posted to the Utah Automated Geographic Reference Center (AGRC) (https://gis.utah.gov/data/sgid-cadastre/parcels/). The parcel data are in the projection NAD 1983 UTM zone 12N.

Initial Data Processing

A point shapefile was created from the Microsoft Excel file including ancillary, pertinent soil boring data, specifically the "Plot ID" and "Depth to Clean (ft)" data. Tetra Tech visually compared the locations of the points to the map provided in the "Volume Tables and Main Volume Exhibit - working.pdf" document (also provided by UPCM) and recent aerial imagery to ensure adequate placement accuracy for subsequent derivation of tailing volume estimates. To align with the parcel data, point data created as part of the Silver Creek OU2/3 Tailing Volume Assessment used the following projection: NAD 1983 UTM zone 12N. There were several soil testing locations where the depth to clean was not achieved due to site conditions (e.g., water backfilling the boring hole). In these cases, the depth to water was used for these locations as a representative value for the "Depth to Clean". These points are marked with inverted, yellow triangles in Figure 1, along with a label of the assumed depth for these points.

Additionally, other points were added to inform subsequent geospatial analyses of tailing volume estimate. Measurements of soil depths to below mine tailing found in the test pits performed on-site circa 2007 were added to the Excel-based data provided by UPCM. Furthermore, based on direction from EPA

(Rob Parker) four lines representing areas where tailings were estimated to not be present at the soil surface (or below) were added to the Excel-based data (Figure 1). Finally, two additional points were added to ensure interpolation output extents met the project's needs (i.e., to the outer edges of OU2 and OU3)--one point to the far southeast of the area of interest, and another to the north of the area of interest. These two points were added with a sufficient distance from the area of interest so as to not impact interpolation outputs, but provide interpolated data for the entire area of interest for subsequent volume estimates.

Tetra Tech
10306 Eaton Place, Suite 300, Fairfax, VA 22030
Tel 703.385.6000 www.tetratech.com

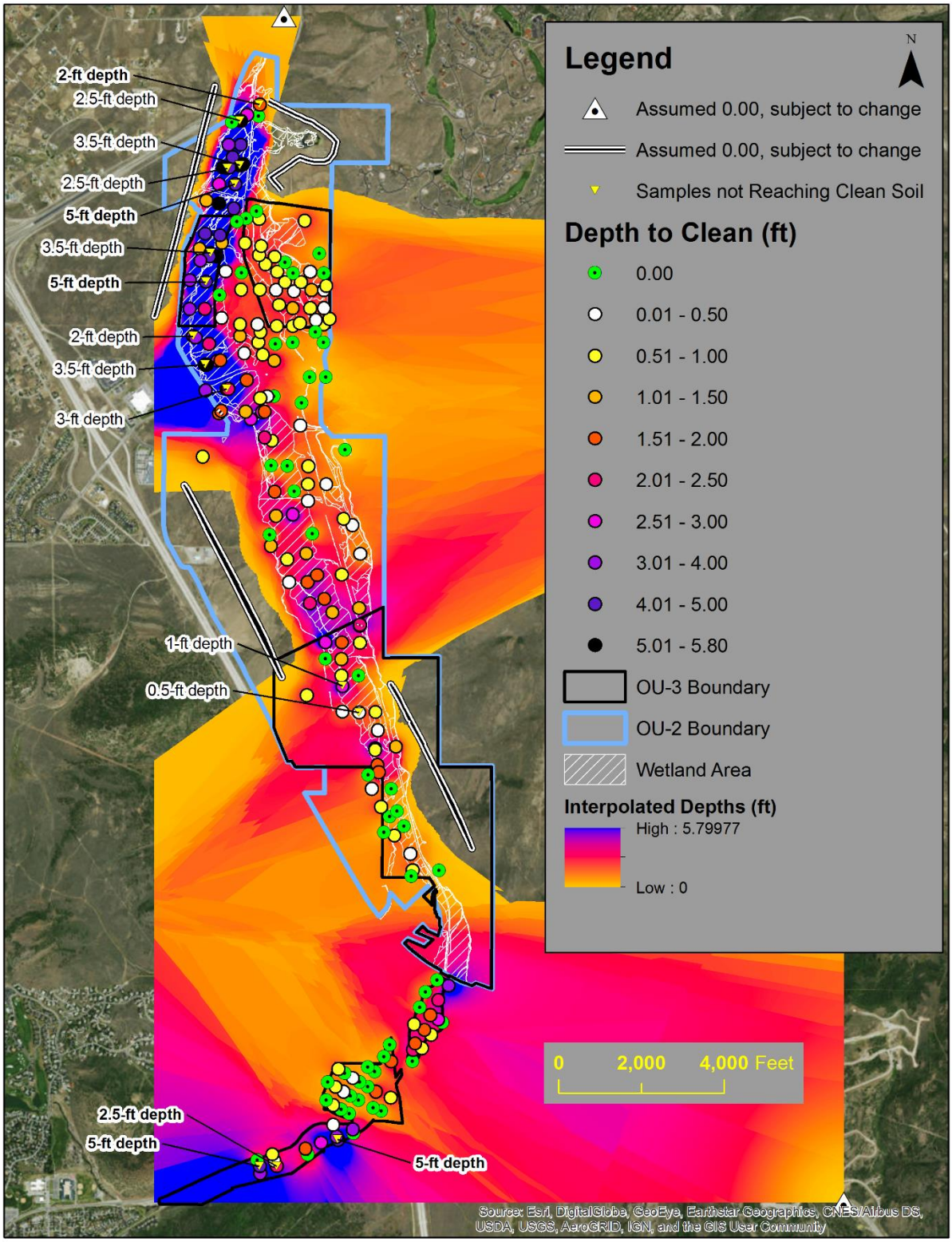

Figure 1. Silver Creek Tailings Estimations – Field-Measured and Assumed Point Data, and Interpolation

Tailings Volume Estimate Methodology

Inverse Distance Weighting (IDW) interpolation was selected as the method to estimate the tailings volume across parcels. IDW creates a smooth, continuous surface of a specified measurable variable using control points. Control points represent the provided soil sample locations and added points (as described above) and the measurable value corresponds to tailing thickness for each location, given by UPCM in feet. IDW interpolates the thickness across all portions of relevant parcels that are within the OU 2/3 boundaries. IDW was selected to mitigate the sparse data across the majority of OU2/3 and create an estimate for each parcel—even those parcels without soil sampling sites within their boundaries. IDW interpolation was used with the default ESRI IDW tool settings (Power of 2, variable search setting with a minimum of 12 points required for each cell's interpolation) outputting a 1-meter resolution, seamless gridded data set.

Next, a shapefile was created from the Summit County "source" parcel file corresponding to any parcel intersected by the area representing OU 2/3 despite the size of the overlap (using the ESRI Intersect tool). For each parcel intersecting the OU2/3 boundary, if the parcel ID was blank or duplicate with another parcel in the parent file, Tetra Tech assigned a number to avoid combining parcels with the same parcel ID for subsequent processing (e.g., Multiple_TTassigned1 and 0_TTassigned1). "Calculate geometry" provided an estimate of the acreage for each unique parcel within the OU 2/3 study area.

The ESRI "Zonal Statistics as Table" tool was used to calculate the sum total of **all** 1-meter grid cell's tailing thickness in feet (as estimated by the IDW output) within each parcel for the entire parcel. This ESRI tool produces a SUM column that represents the "stacking" of every 1-meter grid cell's depth to clean value (i.e., 'height' of tailings under the ground) within each parcel. Therefore, the SUM value is the total height (or, depth) of tailings of **all** cells estimated for each individual parcel. Multiplying the SUM value for each parcel by the size of the grid cells (i.e., 1 meter square) yields a volume estimate. Interestingly, the SUM value (after being converted from feet to meters) happens to also be estimate of Total Volume of Tailings in each parcel (in cubic meters) because; SUM value (in meters) * cell size (1 m * 1 m) does not change the value (Table 1 and Figure 2).

Table 1. Silver Creek Tailings – Parcel Level Estimates from IDW Interpolation

Parcel ID	Total Volume (m3)	Area within OU 2/3 (acres)	Total Parcel Area (acres)
0_TTassigned1	22,035	8.16	13.9
0_TTassigned2	53	0.12	0.1
0_TTassigned3	77	1.36	1.4
0_TTassigned4	-	0.59	40.7
0_TTassigned6	54	0.06	15.5
0_TTassigned7	23	0.03	5.2
0_TTassigned8	2,917	4.91	4.9
HM-1-ROS-4-X	257	0.08	85.9
HSD-24	-	0.04	0.8
HSD-25	-	0.08	0.6
HSD-26	-	0.04	0.6

Parcel ID	Total Volume (m3)	Area within OU 2/3 (acres)	Total Parcel Area (acres)
HSD-27	-	0.03	0.6
HSD-28	-	0.03	0.5
HSD-29	-	0.03	0.6
HSD-30	-	0.03	0.6
HSD-31	-	0.01	0.5
MPSC-6A-X	1,078	0.52	14.1
MULTIPLE_TTassigned1	64,431	89.48	89.5
MULTIPLE_TTassigned2	1	0.00	51.8
NS-PROM-RD	324	1.07	41.2
PCA-88-X	11,049	15.54	15.6
PCA-89-A	64	0.04	12.4
PCA-89-B	18	0.01	0.3
PCA-91-UP-X	47,043	7.89	20.4
PCA-92	143	0.03	41.5
PCA-92-A-2-X	4	0.01	3.3
PCA-92-A-X-X	12,653	16.37	16.6
PCA-92-D-1-X	9,841	22.68	22.8
PCA-98-B-X	4	0.00	0.4
PCA-9-95-1-X	478	0.00	2.2
PCA-9-95-N-2-X	0	0.00	3.3
PCA-SS-98-UP-X	20,139	7.48	7.5
PCBC-1	679	1.50	1.5
PCBC-10	1,287	2.10	2.1
PCBC-11	782	1.24	1.2
PCBC-12	1,021	1.45	1.5
PCBC-13	912	1.09	1.1
PCBC-14	525	0.66	0.7
PCBC-15	601	0.78	0.8
PCBC-16	1,408	1.44	1.4
PCBC-17	878	0.90	0.9
PCBC-18	4,659	4.48	4.5
PCBC-19	4,983	5.12	5.1
PCBC-2	625	1.38	1.4
PCBC-20	1,536	2.00	2.0
PCBC-21	717	1.13	1.1
PCBC-22	462	0.77	0.8
PCBC-23	669	1.18	1.2
PCBC-24	613	1.13	1.1
PCBC-25	486	1.08	1.1

Parcel ID	Total Volume (m3)	Area within OU 2/3 (acres)	Total Parcel Area (acres)
PCBC-26	743	1.70	1.7
PCBC-29	362	0.76	0.8
PCBC-3	372	0.84	0.8
PCBC-30	501	1.14	1.1
PCBC-31	578	1.34	1.3
PCBC-32	1,453	3.15	3.4
PCBC-33	2,990	6.13	6.1
PCBC-34	709	0.72	0.7
PCBC-35	21,310	31.52	31.5
PCBC-4	414	0.95	0.9
PCBC-5	384	0.93	0.9
PCBC-6	272	0.67	0.7
PCBC-7	298	0.67	0.7
PCBC-8	356	0.67	0.7
PCBC-9	665	1.15	1.1
PCBC-B-1	1,401	2.99	3.0
PCH-1-A	53	0.04	5.7
QWTS-1-X	9,809	4.13	4.2
QWTS-2-X	8,196	4.39	4.4
QWTS-3-X	21,687	8.78	8.8
S-303	461	0.95	8.5
S-404	670	0.55	2.8
SCO-C-10-2AM	448	0.41	14.9
SCO-C-AM-X	7	0.36	14.1
SS-21-UP-X	2,650	2.93	4.2
SS-21-X	10,905	8.85	13.4
SS-22-X	1,966	5.95	7.0
SS-23	89	2.45	388.7
SS-26	62	0.73	137.8
SS-27	43,381	151.23	151.2
SS-28-A-1-X	34,374	39.91	39.9
SS-28-A-X	180,855	50.06	50.1
SS-28-UP-X	32,074	13.10	13.1
SS-29	277,681	125.01	126.5
SS-29-B-X	1,590	1.92	42.8
SS-29-X	4,725	1.88	5.6
SS-30	-	1.75	21.1
SS-30-1-X	-	0.07	2.1
SS-30-A	339	0.11	227.0

Parcel ID	Total Volume (m3)	Area within OU 2/3 (acres)	Total Parcel Area (acres)
SS-44	271,900	98.26	98.7
SS-44-A-1	12,998	4.46	4.5
SS-44-B	4,818	4.31	4.3
SS-45-UP-X	692	1.07	1.1
SS-47	94,271	164.43	164.4
SS-47-X	-	0.16	0.7
SS-49	22,856	30.34	30.3
SS-50	89,666	124.67	124.7
SS-51-A	14,939	13.79	13.8
SS-51-B-X	819	1.01	1.0
SS-51-C	842	1.93	333.0
SS-51-C-1-X	779	1.75	1.8
SS-51-C-2-X	16,367	45.64	45.8
SS-51-UP-X	12,397	16.66	16.7
SS-54-A	-	0.01	525.5
SS-55	1,891	4.10	240.0
SS-56	161,502	128.52	128.5
SS-56-A	31,171	49.77	49.8
SS-56-A-1	123,408	159.51	159.5
SS-56-A-1-A	74,351	40.95	40.9
SS-56-A-1-X	284	0.39	1.7
SS-56-C-X	29	0.03	0.3
SS-56-UP-X	19,061	18.70	18.7
SS-57-1-A-X	-	6.79	6.8
SS-57-1-B-X	7,134	111.40	111.4
SS-57-1-X	69	1.94	26.7
SS-64-1000-UP-X	15,748	19.10	19.6
SS-64-A	26,504	154.75	154.7
SS-65-1	8,045	5.32	5.3
SS-65-2	471	0.48	5.0
SS-65-2-1	401	0.32	4.7
SS-65-A-2-A	314	0.28	2.1
SS-65-A-3	10,537	7.89	7.9
SS-65-A-3-1	2,510	4.80	4.8
SS-65-A-5	24,806	40.52	40.5
SS-65-A-6	30,593	15.14	15.1
SS-65-A-9	169	0.46	0.5
SS-65-A-X	582	0.90	70.0
SS-65-B	4,205	11.02	11.3

Parcel ID	Total Volume (m3)	Area within OU 2/3 (acres)	Total Parcel Area (acres)
SS-66	1,176	2.35	631.6
SS-86-91-UP-X	875	0.55	12.6
SS-87	1	0.00	372.3
SS-87-A-X	6	0.00	20.5
SS-88	24,558	15.38	157.1
SS-91-UP-X	9,179	4.87	5.6
SS-92-A-X	557	0.45	31.1
SS-98-F-X	19,201	6.83	31.1

Tetra Tech
10306 Eaton Place, Suite 300, Fairfax, VA 22030
Tel 703.385.6000 www.tetratech.com

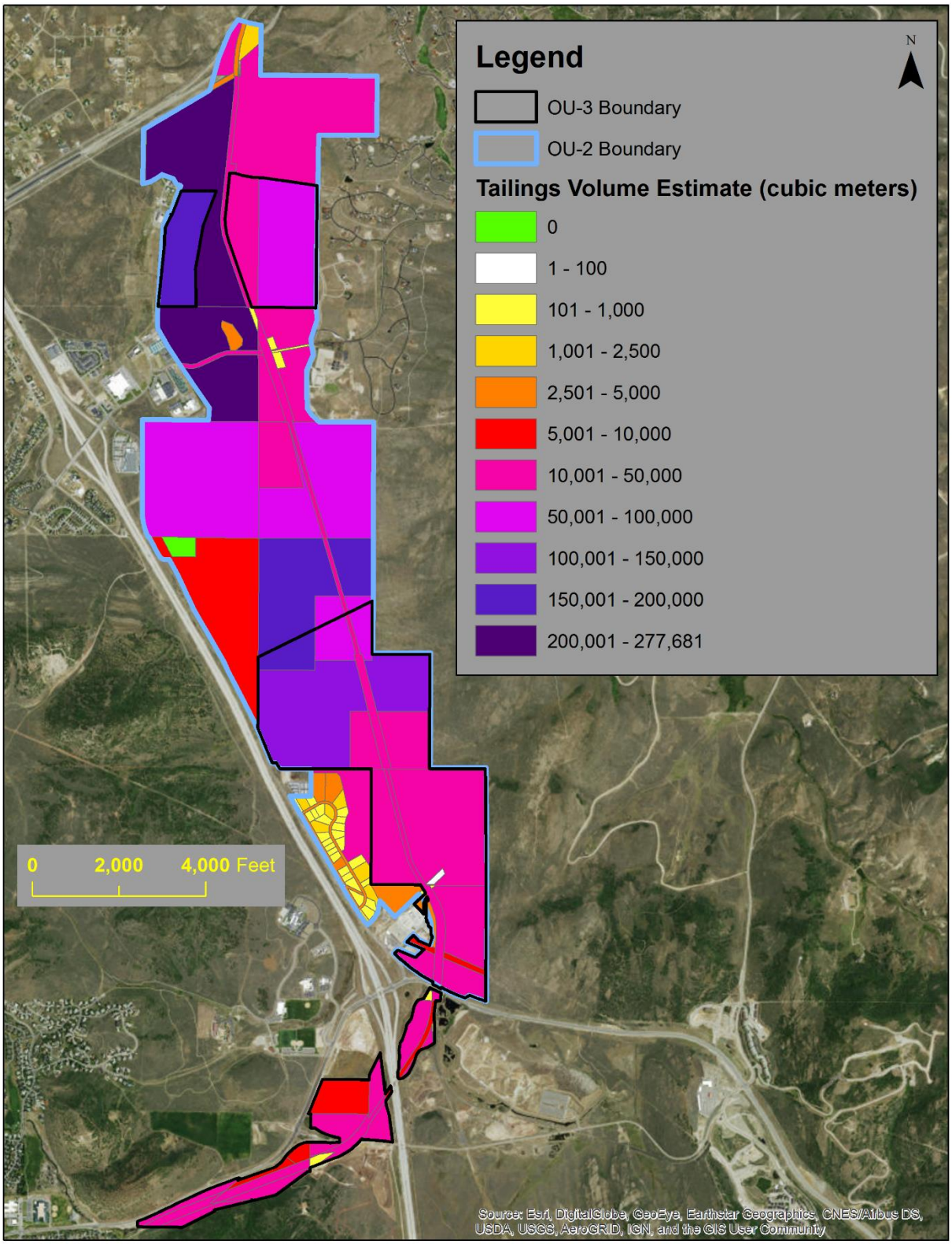

Figure 2. Silver Creek Tailings Estimate – Parcel-Scale Volume Estimates